rises in the gutta-percha tube, the pressure on the valves increases, and the sound becomes more marked; when the fluid on the other hand diminishes, the sounds become less distinct. If the heart be placed horizontally, the sounds become wobbly. The terminal piece of small diameter of a binaural stethoscope gently placed over the aorta at its commencement is most suitable for observing the cardiac sounds in this experiment.

The experiment here described, when first suggested by me, was submitted, with the assistance of Dr. Sibbald, to my lamented friend the late Dr. Sharpey, and to Sir James Paget, who were quite satisfied that with the increase or diminution of the column the sounds closely resembled those of the heart in man, and that they became more or less distinct in proportion to the quantity of fluid contained in the tube.

In conclusion, I may say that I was moved to undertake and continue this inquiry by a desire to obtain a solution of what seemed to be an insoluble problem, and also by a belief that a correct explanation of the cause of the first sound of the heart would be of practical value in the study of the clinical phenomena of diseases of this organ.

I would wish further to add that the explanation of the cause of the first sound of the heart given in this communication, being so different from that hitherto accepted, may seem calculated to create difficulties in the diagnosis of valvular diseases of the heart. Closer consideration will show, however, this not to be the case, but that, like all accurate knowledge, it will be found to simplify, and not to confuse. It will afford an explanation of the relations of certain morbid phenomena which are at present unintelligible, such, for example, as that a systolic murmur may be heard at the apex whilst the first sound is audible at the base free from murmur; and it will serve to encourage a closer study of the relation between muscular contraction of the walls of the heart and the tension of the vessels of the system.

"Mathematical Contributions to the Theory of Evolution. On the Relative Variation and Correlation in Civilised and Uncivilised Races." By Miss ALICE LEE, Bedford College, and KARL PEARSON, M.A., F.R.S., Professor of Mathematics and Mechanics, University College, London. Received April 9,—Read June 3, 1897.

1. The following numerical data were calculated in the hope of reaching some general ideas on the comparative variation and com-

parative correlation in the case of civilised and uncivilised races, and further of determining, if possible, any general law connecting relative sexual variation and relative sexual correlation with the degree of civilisation, and so with what is probably inversely proportional to the degree of civilisation, namely, the intensity of natural selection.

The following two principles seem to flow from a study of variation in the organs of man :—*

(*a*) Civilised man is more variable than uncivilised man.

(*b*) There is a greater equality of variation for the two sexes in uncivilised than in civilised races. Civilised woman appears, on the whole, to be slightly more variable than civilised man.

Both these principles are in accordance with the intensity of the struggle for existence—and the amount, consequently, of natural selection—being greater for uncivilised than for civilised races, and, further, greater for men than for women in the latter races.

The problem of correlation is, however, of a less simple character. While the action of selection can be shown theoretically to reduce variation, it by no means follows that it reduces correlation. Indeed, selection may increase, decrease, or reverse correlation at the very same time as it is reducing variation.† We have then the following problems to guide us in our treatment of actual statistics :—

(*a*) Is correlation more intense among civilised than among uncivilised races?

(*b*) How does the relative correlation of the sexes differ in civilised and uncivilised races?

(*c*) Is there any marked prepotency of either sex in the matter of correlation?

These are the problems which the present calculations were designed, not to definitely solve, but to illustrate.

2. Unfortunately, measurements on living members of uncivilised races are not very numerous, nor for the purposes of correlation generally very satisfactory. There are numerous measurements of skulls and some of bones, but the measurements for each individual race are, from the mathematical standpoint, but few in number. Hence, in the case of each determination of a coefficient of variation or a coefficient of correlation, the probable error will be large. It

* See 'Variation in Man and Woman,' by K. Pearson: "The Chances of Death," vol. 1, pp. 256—377, where some 155 cases of human variation for both sexes are dealt with.

† The theoretical discussion of the relation of selection to correlation forms the subject of a memoir nearly completed. Actually there is some evidence to show higher correlation among the working classes than among the middle and upper classes of a civilised community.

is thus impossible to lay much stress on any individual relative difference; we are bound to consider only the *general trend* of our results. In order, however, to make the probable errors as small as possible it is desirable in the case of correlation to make the coefficients as large as possible. Now, for measurements on the skull, the correlation is small, but, for the long bones, it is large. Hence, the latter will give better results for comparative purposes, if the series be smaller than the former. They have accordingly been selected for the present investigation. In all cases the standard deviations, coefficients of variation, and coefficients of correlation have been calculated *without grouping* by means of the formulæ given in a memoir on "Regression, Heredity, and Panmixia."* The standard deviations and coefficients of correlation had their errors determined by the formulæ of the same memoir (pp. 266 and 275); the coefficients of variation have for probable error, if n be the number of measurements in the series, and V the coefficient,

$$0{\cdot}6745 \frac{v}{\sqrt{2n}}\left[1 + 2\left(\frac{v}{100}\right)^2\right]^{\frac{1}{2}},$$

or sensibly, $0{\cdot}6745 \dfrac{v}{\sqrt{2n}}$, since $v/100$ is of the order 0·05, for our present investigations. It will thus be seen that the probable error of a coefficient of variation can, like that of a standard deviation, amount to a considerable percentage of its value if n be small. For example, if $n = 23$ (case of the Aino women) it can amount to about 10 per cent.; while for $n = 50$ (case of the French men or women) it will amount to 6·7 per cent. The probable errors of the standard deviations will also in the two cases amount to 10 and 6·7 per cent. respectively. On the other hand, if n be as small as 23, the probable error of the coefficent of correlation will only be 2·2 per cent. of its value if r be as large as 0·9, and only 6·56 per cent. of its value if $r = 0{\cdot}75$. On the other hand for $n = 50$ the probable errors of r for the two cases of $r = 0{\cdot}9$ and $0{\cdot}75$ are respectively 1·5 and 4·45 per cent. It thus appears that if correlation be large, or even fairly large, it can be determined with far less probable error than variation. The results for correlation are thus likely in the present case to be more significant than those for variation.

3. As to the material itself the French measurements are taken from a work by Dr. E. Rollet: 'De la Mensuration des Os longs des Membres,' published in the 'Bibliothèque d'Anthropologie Criminelle,' Lyons, 1889. The bodies from which the bones were taken having passed through the post-mortem room, the sex was known without question. The right member was always taken

* 'Phil. Trans.,' A, vol. 189 pp. 265 and 277.

except in the few cases where its length was not recorded. In these cases in order not to diminish the already small series, the left member was taken. Of the two measurements of the femur given by Rollet the longer was taken.

The measurements of the Aino bones were taken from a work by Koganei in the 'Mittheilungen aus der Medicinischen Facultät der K. Japanischen Universität,' Bd. 2—Tables, Tokio, 1894; and the same rule observed. The Japanese returns, while more extended in the variety of bones measured than the French, yet contain fewer individuals, and in many respects do not seem to us so reliable as the latter.* In both cases the maximum length of femur, humerus, radius, ulna, fibula, and clavicle (F_1, H, R_1, U, Fib., and Cl.) were measured. For the Aino we have in addition to the lengths (R_2 and T_2) of the radius and tibia from centre to centre, the length (F_2) of head and neck of femur, and the scapular index (Sc.) or ratio of breadth to length of scapula. The Aino measurements give the maximum length of the tibia (T_1) as well as the length from centre to centre. The French measurements give the length of the tibia, excluding the spine and including the malleolus (T_3). In order that our results might be of service to Mr. E. Warren, who is dealing at length with the Libyan long bones, the radius correlations for the Aino were calculated for R_2 and not for R_1, as they are in the case of the French. The results for French and Aino are not strictly comparable in this case. The same holds for the measurement of the tibia. Probably Rollet's T_3 measurement corresponds more closely to Koganei's measurement No. 13 (T_1) than to his No. 14 (T_2). Both T_1 and T_3 are greater, T_2 is less than the fibula in length.

We have dealt with the Aino T_2 instead of T_1, however, for the purpose of comparison with the Libyans.

The following tables give the chief results :—

* One female humerus (No. 42) was noticed to be very discordant. As it would be excluded as a "discordant observation" by Chauvenet's criterion it was rejected; it was afterwards found to be described in the text as deformed. The male humerus (No. 31) should be 279 and not 379 cm. long. The female ulna, No. 4, (270 cm.) has been rejected. It is out of all proportion to the corresponding humerus, as judged by the whole range of humerus ulna measurements we have come across. Yet notwithstanding its disproportionately large size, Koganei describes it (p. 127) as much bent. The male fibula, No. 19, is excessive as compared with either femur or tibia. There did not, however, seem sufficient warrant for rejecting it. Its being a misprint or mismeasurement would account for the low values obtained for the ♂ Aino correlation of fibula with femur and tibia. Without it the fibula-tibia correlation = 0·9492.

Table I.—Variation ♂.

(Absolute Measurements in Centimetres.)

Organ.	Aino.				French.			
	No.	Mean.	S.D.	C. of V.	No.	Mean.	S.D.	C. of V.
Femur, F_1	44	40·770 ±0·193	1·898 ±0·136	4·655 ±0·336	50	45·228 ±0·226	2·372 ±0·160	5·425 ±0·354
Femur, F_2	41	6·790 ±0·041	0·393 ±0·029	5·788 ±0·427	—	—	—	—
Tibia, T_1	38 (T_1)	33·895 ±0·183	1·668 ±0·129	4·921 ±0·381	50 (T_3)	36·806 ±0·172	1·799 ±0·121	4·888 ±0·330
Tibia, T_2	40	31·740 ±0·168	1·577 ±0·119	4·968 ±0·375	—	—	—	—
Fibula, Fib.	32	33·263 ±0·189	1·585 ±0·134	4·765 ±0·403	50	36·272 ±0·172	1·801 ±0·121	4·965 ±0·335
Humerus, H......	45	29·502 ±0·135	1·343 ±0·095	4·552 ±0·322	50	33·010 ±0·147	1·538 ±0·104	4·659 ±0·314
Radius, R_1	39	22·913 ±0·121	1·117 ±0·086	4·875 ±0·375	50	24·394 ±0·112	1·170 ±0·079	4·796 ±0·323
Radius, R_2	39	21·549 ±0·114	1·060 ±0·081	4·919 ±0·376	—	—	—	—
Ulna, U.	38	24·603 ±0·121	1·109 ±0·086	4·508 ±0·350	50	26·052 ±0·125	1·309 ±0·088	5·025 ±0·339
Clavicle, Cl.	35	14·57 ±0·088	0·776 ±0·062	5·326 ±0·426	—	—	—	—
Scapular Index, Sc.	33	65·56 ±0·487	4·15 ±0·344	—	—	—	—	—

Table II.—Variation ♀.
(Absolute Measurements in Centimetres.)

Organ.	Aino.				French.			
	No.	Mean.	S.D.	C. of V.	No.	Mean.	S.D.	C. of V.
Femur, F_1	25	38·204 ±0·215	1·594 ±0·152	4·170 ±0·398	50	41·570 ±0·215	2·255 ±0·152	5·425 ±0·366
Femur, F_2	24	6·200 ±0·037	0·269 ±0·026	4·339 ±0·422	—	—	—	—
Tibia, T_1	22 (T_1)	31·859 ±0·206	1·434 ±0·146	4·501 ±0·458	50 (T_3)	33·444 ±0·178	1·863 ±0·126	5·571 ±0·376
Tibia, T_2	24	29·800 ±0·217	1·576 ±0·153	5·289 ±0·515	—	—	—	—
Fibula, Fib.	20	31·210 ±0·243	1·612 ±0·172	5·165 ±0·551	50	33·030 ±0·175	1·837 ±0·124	5·562 ±0·375
Humerus, H.	27	27·7185 ±0·164	1·242 ±0·116	4·481 ±0·419	50	29·766 ±0·145	1·525 ±0·103	5·123 ±0·346
Radius, R_1	24	21·083 ±0·139	1·009 ±0·098	4·786 ±0·466	50	21·486 ±0·104	1·095 ±0·074	5·096 ±0·344
Radius, R_2	24	19·929 ±0·136	0·991 ±0·096	4·973 ±0·484	—	—	—	—
Ulna, U.	21	23·071 ±0·173	1·176 ±0·122	5·095 ±0·530	50	23·210 ±0·110	1·154 ±0·078	4·972 ±0·335
Clavicle, Cl.	20	13·235 ±0·137	0·908 ±0·097	6·861 ±0·732	—	—	—	—
Scapular Index, Sc.	20	68·64 ±0·538	3·57 ±0·381	—	—	—	—	—

Table III.—Correlation ♂ and ♀.*

Organs.	♂.				♀.			
	Aino.		French.		Aino.		French.	
	No.	r.	No.	r	No.	r.	No.	r.
Femur and tibia, F_1. and T_2......	40 (T_2.)	0·8266 ±0·0260	50 (T_3.)	0·8058 ±0·0261	24 (T_2.)	0·8457 ±0·0299	50 (T_3.)	0·8904 ±0·0148
Femur and humerus, F_1. and H. ..	42	0·8584 ±0·0208	50	0·8421 ±0·0212	23	0·8722 ±0·0254	50	0·8718 ±0·0173
Femur and radius, F_1. and R_2.....	37 (R_2.)	0·7891 ±0·0328	50 (R_1.)	0·7439 ±0·0341	22 (R_2.)	0·7039 ±0·0593	50 (R_1)	0·7786 ±0·0296
Tibia and humerus, T_2. and H.....	39 (T_2.)	0·7447 ±0·0257	50 (T_3.)	0·8601 ±0·0188	22 (T_2.)	0·7277 ±0·0547	50 (T_3.)	0·8180 ±0·0244
Tibia and radius, T_2. and R_2......	35 (T_2. and R_2.)	0·8655 ±0·0216	50 (T_3. and R_1.)	0·7804 ±0·0294	21 (T_2. and R_2.)	0·7452 ±0·0525	50 (T_3. and R_1.)	0·8053 ±0·0261
Clavicle and humerus, Cl. and H...	34	0·4393 ±0·0855	—	—	20	0·6309 ±0·0768	—	—
Clavicle and scapula, Cl. and Sc...	30	0·1738 ±0·1177	—	—	17	0·1191 ±0·1601	—	—

Table III.—Correlation ♂ and ♀—*continued.**

Organs.	♂				♀.			
	Aino.		French.		Aino.		French.	
	No.	r.	No.	r.	No.	r.	No.	r.
Humerus and radius, H. and R_2...	39 (R_2.)	0·7763 ±0·0338	50 (R_1.)	0·8451 ±0·0208	22 (R_2.)	0·7386 ±0·0526	50 (R_1.)	0·8515 ±0·0200
Tibia and fibula, T_2. and Fib......	37 (T_2.)	0·8882 ±0·0190	50 (T_3.)	0·9575 ±0·0057	18 (T_2.)	0·9670 ±0·0074	50 (T_3.)	0·9803 ±0·0027
Femur and fibula, F_1. and Fib.....	32	0·8310 ±0·0284	50	0·8193 ±0·0243	19	0·8890 ±0·0242	50	0·9106 ±0·0120
Humerus and ulna, H. and U.....	38	0·7653 ±0·0360	50	0·7669 ±0·0312	20	0·7479 ±0·0532	50	0·8600 ±0·0188
Radius and ulna, R_2. and U.......	38 (R_2.)	0·9780 ±0·0056	50 (R_1.)	0·8767 ±0·0166	20 (R_2.)	0·9754 ±0·0525	50 (R_1.)	0·9244 ±0·0102

* The probable error of r, the coefficient of correlation, is calculated from the formula given in the memoir cited p. 345. That formula is based on the assumption that the probable error of r is uncorrelated with the probable errors of the variations of the two correlated organs, σ_1, σ_2. If this correlation be taken into account, the formula for r is somewhat modified, and the values calculated must be slightly increased. The probable error of r used is actually that of an array of r's corresponding to the given values of σ_1 and σ_2.

Table IV.—Sexual Ratios: ♂ to ♀.

Organ.	Means.		Variations.	
	Aino.	French.	Aino.	French.
Femur, F_1.	1·067	1·087	1·116	1·000
Femur, F_2.	1·095	—	1·333	—
Tibia, T_1.	1·063	—	1·093	—
Tibia, T_2.	1·065	(T_3) 1·101	0·939	(T_3) 0·877
Fibula, Fib.	1·066	1·098	0·922	0·893
Humerus, H.	1·064	1·109	1·016	0·909
Radius, R_1.	1·087	1·135	1·019	0·941
Radius, R_2.	1·081	—	0·989	—
Ulna, U.	1·066	1·122	0·885	1·011
Clavicle, Cl.	1·101	—	0·776	—
Scapular Index, Sc.	0·955	—	1·162	—
Mean of F_1., T_2., Fib., H., R_2., and U.	1·068	1·109	0·978	0·939
Mean of all measurements	1·065	—	1·023	—

Table V.—Sexual Ratios: ♂ to ♀.
Correlations.

Organs.	Aino.	French.
Femur and Tibia, F_1. and T_2.	0·977	(T_3.) 0·905
Femur and Humerus, F_1. and H.	0·984	0·966
Femur and Radius, F_1. and R_2.	1·121	(R_1.) 0·957
Tibia and Humerus, T_2. and H.	1·023	(T_3.) 1·051
Tibia and Radius, T_2. and R_2.	1·161	(T_3, R_1) 0·969
Clavicle and Humerus, Cl. and H.............	0·696	—
Clavicle and Scapular Index	1·459	—
Humerus and Radius, H. and R_2.............	1·051	(R_1.) 0·992
Tibia and Fibula, T_2. and Fib.	0·918	(T_3.) 0·977
Femur and Fibula, F_1. and Fib.	0·935	0·900
Humerus and Ulna, H. and U.	1·023	0·892
Radius and Ulna, R_2. and U.................	1·003	(R_1.) 0·948
Mean (excluding Clavicle and Scapular Index correlations)	1·020	0·956
Mean (including these)	1·029	—

Table VI.—Racial Ratios: French to Aino.

Organ.	Means.		Variations.	
	♂.	♀.	♂.	♀.
Femur, F_1...	1·109	1·088	1·165	1·301
Tibia, T_2. or T_3.......	1·159	1·122	0·983	1·053
Fibula, Fib.	1·090	1·058	1·042	1·077
Humerus, H.........	1·119	1·074	1·023	1·143
Radius, R_1. or R_2.....	1·132	1·078	0·975	1·025
Ulna, U.............	1·059	1·006	1·115	0·976
Means	1·111	1·071	1·050	1·096

Rate of progression of males over females in means = 1·037.
Rate of progression of females over males in variations = 1·043.

Table VII.—Racial Ratios: French to Aino.

Correlations.

Organs.	♂	♀
Femur and Tibia, F_1. and T_2. or T_3..........	0·975	1·053
Femur and Humerus, F_1. and H.	0·981	1·000
Femur and Radius, F_1. and R_2. or R_1...	0·943	1·106
Tibia and Humerus, T_2. or T_3., and H.	1·155	1·124
Tibia and Radius, T_2. and R_2. or T_3. and R_1...	0·902	1·081
Humerus and Radius, H. and R_2., or R_1......	1·089	1·152
Tibia and Fibula, T_2. and Fib...............	1·078	1·014
Femur and Fibula, F_1. and Fib.	0·986	1·024
Humerus and Ulna, H. and U.	1·002	1·150
Radius and Ulna, R_2. or R_1. and U	0·896	0·948
Means	1·0007	1·065

Rate of progression of females over males in correlation = 1·065.

5. Now the tables illustrate at once how little can be judged for the problem of variation from any *single* measurement when the series are so small, and the measurements do not entirely correspond. We are forced to argue only from the general trend of the whole group. On the other hand, with the exception of the clavicle and scapular index, the probable errors in the correlation are sufficiently small for fairly good inferences to be drawn.* We will deal first with the general problems with regard to sex, and then with those bearing on race.

6. *Sexual Ratios.*—In all cases the sexual ratio for the mean length of any bone is greater than unity. Grouping both French and Aino together, we have 17 series giving a mean sexual ratio for the long bones in civilised and uncivilised man of 1·088. This agrees well with the value 1·089 determined for a series of rather different contents in the paper on 'Variation in Man and Woman' (*loc. cit.*, p. 374) referred to above. Turning to sexual ratio in variation, we find, for French and Aino together, the value 0·976. The value as

* So far as these relate to the nature of the correlation between individual long bones, we have placed our results at the disposal of Mr. E. Warren, who is dealing with the long bones of the Libyan (?) skeletons.

determined from about 155 series (*loc. cit.*, p. 373) was 0·973 ± 0·007. A special study of the long bones thus seems to confirm the result previously reached, that woman is, on the whole, slightly more variable than man. Lastly, turning to the sexual ratio in correlation, we find that in 14 out of 22 cases, woman is more highly correlated than man, the mean sexual ratio in correlation being 0·992. So far, then, as the present results go, they seem to indicate that man, while larger, is less variable, and less highly correlated than woman.

When we take, however, race into consideration, there are additional factors which somewhat modify these conclusions. In the first place there is, of course, no suggestion that the modern French are lineal descendants of the Aino, but it does not seem an improbable supposition that the French have at one time passed through a stage somewhat similar to that primitive condition in which we now find the Aino. Assuming this for the purpose, at any rate, of comparison, we find that the transition from the uncivilised to the civilised condition is accompanied by well-marked changes in the sexual ratios. They are as follows :—

(i.) Man tends to gain in size on woman.
(ii.) Woman tends to gain in variability on man.
(iii.) Woman tends to gain in correlation on man.

In other words, primitive man and woman are more nearly equal in size, variability, and correlation than highly civilised man and woman. Relative to woman, man's gain in size has been accompanied by a loss in variability and in the correlation of his parts. So far as size and variability are concerned, these results are in accordance with the far wider series of measurements dealt with in the paper on 'Variation in Man and Woman.' The result as to correlation was there suggested (*loc. cit.*, p. 375) on very slight evidence. Before we make any suggestion as to the bearing of these results on natural selection it will be well to examine the racial ratios.

7. *Racial Ratios.*—In means both ♂ and ♀ French are in every measurement larger than ♂ and ♀ Aino, but the difference is greater for males than females. In variations the ♂ and ♀ French have progressed in nearly all cases on the ♂ and ♀ Aino (the tibia in the male and the ulna in the female are apparently exceptions). But while the females have progressed less rapidly than the males in absolute size, they have progressed more rapidly in variation. Lastly, in correlation the French males have more correlation than the Aino males in four organs, and less in six organs, the general mean result being almost equality of correlation. On the other hand, the French females are only inferior to the Aino in one case, and the final result is a very sensible progress in correlation. The general

conclusion would then be that, with increased civilisation, absolute size* and variation tend to increase; while correlation, to judge by the males, is stationary; to judge by the females, tends to increase.

It will be found somewhat difficult to reconcile these results with any simple applications of the principle of natural selection. In the first place increased variation undoubtedly suggests a lessening of the struggle for existence, and there can be no question that this increase has gone on among civilised races (see 'Variation in Man and Woman'). The lessening of the struggle has probably been greater for woman than man; hence the principle of natural selection might help to explain the preponderance of variability in civilised woman. The increase in size with civilisation seems, on the average, also incontestable. But is it the effect of lessening the struggle for existence? The possibilities may, perhaps, be summed up as follows:—

(*a*) The civilised races may have survived owing to their superior size. It may be a result of the struggle in the past. To this must be objected that the increase of size appears to be a progressive change still going on, and yet increase of variation should show a lessening struggle for existence.

(*b*) The effect of suspending natural selection may be to increase size. This would be a blow for panmixia, for we might naturally have expected a regression to the smallness of the more primitive races. It would leave unexplained the apparently smaller progress of women as compared with men, for in their case we might argue from the variation that the struggle for existence is relatively less than in the case of man.

(*c*) The larger size of the civilised races may be due to better food supply and better physical training: in short it may be due, not to evolution, but to better conditions of growth. This hypothesis does not involve the assumption that acquired characters are inherited. Diminish the food supply and abolish physical training and the size would sink to the level at which natural selection had left it. Physical training in civilised races being usually more adequate in the case of man than of woman would, perhaps, explain why man has progressed more rapidly in size than woman. It seems impossible, taking variation as a measure of the intensity of selection, to reconcile the relative increases in size of man and woman with any direct effect of natural selection.

* This is only *generally* true, not in every individual case. The French femur is longer than that of the Aino, of neolithic man, and of the ancient inhabitants of the Canary Islands. On the other hand, the French femur appears to be slightly less than the Libyan, although the humerus is somewhat greater. The French women appear in all long bones less than the Libyan women.

8. To sum up, then, the following results seem *suggested* by these measurements.*

(i.) Civilised man has progressed generally on primitive man in size, variation, and correlation.

(ii.) This progression can hardly be accounted for by increased selection (because of the increased variation), nor by decreased selection (because it is inconsistent with the relative changes in male and female size). It might possibly be accounted for by decreased selection and improved physical conditions.

(iii.) Woman is more variable than man in civilised races.

(iv.) Woman is more highly correlated than man in civilised races.

(v.) In uncivilised races the sexes are more nearly equal in the matter of size, variation, and correlation than in the case of civilised races.

(vi.) It is impossible to say that civilised woman is nearer to the primitive type than civilised man, for while civilised man differs more from the primitive type than civilised woman, so far, probably, as absolute size is concerned, he has made only about half her progress in variation, and hardly any progress at all in correlation.

(vii.) The causes (*e.g.*, lessening of selection) which tend to increase variation may also increase correlation. In other words, the intensity of the struggle for existence is not necessarily a measure of the intensity of correlation.*

The measurements made by Mr. Warren on the Libyans, the results of which he has kindly favoured us with, are, on the whole. fairly in accordance with the above conclusions. He finds for the

Mean of the sexual ratio of the means	1·092
,, ,, ,, the variations .	1·028
,, ,, ,, the correlations	1·068

The corresponding quantities for the French are: 1·109, 0·939, 0·956, or, we concluded, that in passing from uncivilised to civilised peoples, from Libyan to French, the men gain on the women in size—here very slightly, and the women gain upon the men very markedly in variation and correlation.

These results are merely suggestions, but they may possibly serve to emphasise the importance of a careful measurement of the long bones of, say, 100 members of both sexes for a series of civilised and uncivilised races. In the former case at least there does not appear to be any real difficulty, except the need of co-operation, in obtaining

* The mathematical theory of selective correlation shows that the close selection of an organ, say the femur, may actually tend to reduce the correlation between two other organs, say the humerus and the radius.

measurements similar to those of M. Rollet for both English and Germans. The value of such statistics for comparative purposes would be very great.

"On the Nature of the Contagium of Rinderpest. Preliminary Communication." By ALEXANDER EDINGTON, M.B., F.R.S.E., Director Colonial Bacteriological Institute, Cape Colony. Communicated by Sir JAMES CRICHTON BROWNE, M.D., LL.D., F.R.S. Received March 22,—Read June 3, 1897.

In the following pages it is proposed to communicate to the Royal Society the results of experiments made in South Africa on the infectivity of the blood of animals affected with Rinderpest. The experiments were all made on cattle kept under conditions in which accidental spontaneous infection could with certainty be excluded. These experiments had been concluded in 1896, before the arrival of Dr. R. Koch in South Africa, and their results had been communicated to him on his arrival.

1. The blood of an animal ill with rinderpest, when taken during the febrile stage or previous to death, and injected subcutaneously or intravenously into healthy cattle, produces the typical disease—rinderpest, provided the blood is prevented from coagulating.

2. The onset of coagulation and actual coagulation of the blood exert a marked destructive influence on the virulence of such blood.

3. The best method of obtaining virulent blood is to draw it aseptically from the jugular vein of an animal ill with rinderpest, and to mix it immediately with a 1 per cent. solution of citrate of potash, the latter previously well sterilised, in the proportion of 2—3 parts of blood to 1 part of citrate of potash solution. Such blood, as has been shown, remains fluid.

4. This citrate of potash mixture of blood proves virulent in the first few days, generally not exceeding six days; after six days' keeping the virulence becomes rapidly weakened, so that after nine days the blood mixture is altogether inert.

5. Admixture of glycerine to citrate blood does not *cæteris paribus* interfere with the virulence of such blood. Glycerine added to fresh blood does interfere with the virulence of the latter on account of the coagulation of the blood.

6. The nasal mucus of an infected animal when used fresh and rubbed into the nostrils of normal cattle, produced in all instances typical rinderpest. We have never had a single failure in attempting to produce the disease by this means. By keeping the nasal mucus, even for a few hours, its virulence becomes markedly less.